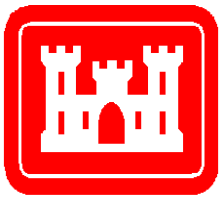
FINAL CONSTRUCTION COMPLETION REPORT
For The Pemaco Remedial Action

PEMACO SUPERFUND SITE
5050 E. Slauson Avenue
Maywood, California

Prepared for:

U.S. Environmental Protection Agency
Region IX
San Francisco, California

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska



Prepared by:

T N & Associates, Inc.
Engineering and Science
317 E. Main Street
Ventura, California 93001

September 30, 2007

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ACRONYMS AND ABBREVIATIONS

AHA	Activity Hazard Analysis
AST	above ground storage tanks
CCR	Construction Completion Report
CCR	Construction Completion Report
CPVC	Chlorinated Poly (Vinyl Chloride)
DPE	Dual-phase Extraction
EDD	electronic data deliverables
EPA	Environmental Protection Agency
EPP	Environmental Protection Plan
ERH	Electrical Resistive Heating
FQI	Cumulative meter for water
FT	Feet
FTO	Flameless Thermal Oxidizer
GAC	Granular Activated Carbon
GTS	Groundwater Treatment System
Hg	Mercury
in.	Inches
LEL	Lower Explosive Level
LRPS	liquid-ring vacuum pumps
MOMP	Management and Operation and Maintenance Plan
MSDS	Material Safety Data Sheet
O&M	Operation and Maintenance
OU	Operational Unit
P	Perched Well
PI	Pressure Indicator
PM	project manager
psig	per square inch gauge
QA	quality assurance
QC	quality control
RACR	Remedial Action Construction Reports
RI	Remedial Investigation
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SCADA	System Control and Data Acquisition
SCAQMD	Southern California Air Quality Management District
Site	Pemaco Site
SMC	System Main Computer
SQ	Sturdi-Quick
SVE	Soil Vapor Extraction
TCE	Trichloroethene
The Park	Maywood Riverside Park
TI	Temperature Indicator
TN&A	T N & Associates, Inc.
TRS	Thermal Remediation Services, Inc.
USACE	United States Army Corp of Engineering
UST	underground storage tanks
VFD	Variable Frequency Drive

ACRONYMS AND ABBREVIATIONS (CONTINUED)

VMP	Vapor Monitoring Points
VOCs	volatile organic compounds
VR	Vapor Recovery Well
VTS	Vapor Treatment System

1.0 INTRODUCTION

1.1 PURPOSE OF CONSTRUCTION COMPLETION REPORT

The purpose this Construction Completion Report (CCR) is to document the activities conducted by T N & Associates (TN&A) at the Pemaco Superfund Site (Site) under U. S. Army Corps of Engineers (USACE) contract DACA# 4500-D-0066 for Pemaco Superfund Site Remedial Action. The USACE provided contract management and construction oversight for the U.S. Environmental Protection Agency (EPA). At the time of this report, the construction phase of this project has been completed. There are ongoing improvements and minor additions of equipment to decrease downtime and maintenance, increase ease of operation, and implement additional site security.

This CCR consists of the subject narrative, tables and appendices including the as-built design drawings and photos of construction. The appendices include the following information:

- **Appendix 1** includes the drawings of the well field, treatment system details, equipment layout, trench location plans, well vault details, piping and instrumentation diagrams, and additional system details.
- **Appendix 2** contains daily quality control (QC) reports and weekly reports since August, 2005.
- **Appendix 3** contains six (6) volumes of photograph logs that show the various stages of each construction phase. Appendix 1 has the set of drawings for the treatment building.
- **Appendix 4** includes ERH construction plan and piping layout.
- **Appendix 5** contains well tables and drill logs.
- **Appendix 6** has concrete compression, bolt, rebar, and compaction test reports for the treatment compound building and foundation.
- **Appendix 7** has the set of drawings and calculations for the treatment building.
- **Appendix 8** contains tables and documents related to construction delay caused by the subcontractor Sturdi-Quick (SQ). Compact Discs (CDs) of all the drawings and photos are included with the report.
- **Appendix 9** contains scopes of work for construction tasks requested by the EPA and USACE.

1.2 PROJECT BACKGROUND

The Site is comprised of 1.4 acres located in a mixed industrial and residential neighborhood in Maywood, Los Angeles County, California. Drawing G-1 in Appendix 1 is the Title Sheet of the design drawings package and shows the Site location and vicinity maps (TN&A 2006a). The Pemaco facility formally operated as a custom chemical blender from the 1950s until 1991. A wide variety of chemicals were used and stored on site including chlorinated and aromatic solvents, flammable liquids, oils and specialty chemicals. These chemicals were stored in drums, aboveground storage tanks (ASTs) and underground storage tanks (USTs). In 1991 the facility was abandoned by its owner. The EPA removed UST storage tanks and chemicals that were stored in drums between 1992 and 1998.

Environmental assessments performed between 1990 and 1999 identified soil and groundwater contamination that originated from the blending and storage of chemicals at the Site. A soil vapor extraction (SVE) system was installed after the underground storage tanks were removed in 1998 and operated until 1999.

The EPA listed the Site on the National Priority list in 1999, and TN&A performed a full-scale Remedial Investigation (RI) between January 2001 and November 2001. TN&A conducted treatability tests including aquifer testing in December 2001 and a high vacuum dual phase extraction pilot test in December 2002. An additional "source" area evaluation was performed in September 2003 via membrane interface probe. The Record of Decision (ROD) for the soil vapor and groundwater systems was finalized in January 2005. Groundwater monitoring, "data gap" investigations, and pilot-scale activities for the evaluation of remedial technologies have been in progress for the Site since May 2001.

The City of Maywood, in conjunction with the Trust for Public Land, and other agencies, developed the Site and adjacent properties to build the Maywood Riverfront Park ("the Park"). This public recreational park was completed during June 2006.

The primary remedies implemented at the Site are Dual-Phase Extraction (DPE), where vapor and liquids are brought to the surface through a network of extraction wells; and thermally-enhanced DPE, where the subsurface is heated to the boiling temperature of water, and vapor and liquids are brought to the surface through a network of extraction wells. Secondary remedies consist of bioremediation of groundwater with continued groundwater pump and treat.

The method for heating the soil is Electrical Resistive Heating (ERH). ERH at the Site is accomplished by the installation of electrodes into the subsurface in the most contaminated part of the site (approximately 14,000 square feet). Electrical current flows from one electrode to another and the soil acting as a "resistor" heats up.

The reasons for heating the soil in the deeper zones are to:

1. Greatly increase the rate of contaminant removal; and
2. Increase soil permeability in order to facilitate contaminant recovery from fine-grained soils.

Because of the effectiveness of the heating, the ERH phase of remediation will be significantly shorter than the DPE phase, although some DPE wells will be operated during the thermal phase.

Both DPE and ERH technologies will use the same extraction and treatment equipment. This CCR addresses the major elements of the above and below ground construction; and summarizes operation, maintenance, data requirements, and response actions for the system operation.

1.3 DESCRIPTION OF TREATMENT PROCESS

The remediation system for the Site is a semi-automated, vapor and groundwater extraction and treatment system that was designed to reduce the mass of volatile organic compounds (VOCs) present in soil and groundwater at the site. The groundwater treatment system and vapor treatment system were designed to operate independently of each other. However, since the vapor treatment system does discharge liquid condensate into the groundwater treatment system, the necessary safeguards were programmed into the control software to link the two systems. In addition to the many "programmed" safeguards, the remediation system is located

within a steel frame building that sits atop a 4-inch high concrete containment berm and foundation. The berm and foundation are designed to capture any possible spills or leaks.

Groundwater is extracted from the subsurface using down well pneumatic submersible pumps in the deep wells and “stingers” in the shallower perched zone wells. Thirty-two total fluid pumps in the Exposition Aquifer and 23 perched aquifer (DPE) wells extract groundwater at approximately 40 gpm. The ERH will be performed using 58 electrodes in the area of highest Trichloroethene (TCE) impact. Soil vapor extraction (SVE) will be conducted concurrently from the 58 electrodes, 29 VR wells, and selected perched zone wells to remove contaminated soil vapor in the ERH area and perched groundwater zone. The vapor extraction system is designed to operate at 1000 scfm, and can treat a vapor stream with a Lower Explosive Level (LEL) of approximately 25%.

Piping from the extraction wells is below ground and piping in the treatment plant is aboveground. The remediation system will separate the condensate from extracted vapors and treat the removed condensate and groundwater using liquid-phase carbon adsorption. The carbon adsorption vessels are operated in series prior to discharge to the sanitary sewer. County Sanitation District No. 2 of Los Angeles County, Industrial Waste Section sampling requirements are performed in accordance with the sewer discharge permit. The current operating scenario indicates that discharge will be kept, on average; two orders of magnitude below the sewer permit discharge limits for VOCs which is 1000 ppb.

Treatment of the contaminated soil vapors is by a Flameless Thermal Oxidizer (FTO) followed by treatment through vapor-phase carbon adsorption units. The vapors exiting the FTO must be “conditioned’ by removing excess heat and moisture content before entering the two vapor phase carbon vessels, that are operated in series. Vapor extraction will be conducted concurrently with groundwater extraction, but the vapor treatment system will be able to run independently of the groundwater treatment system. The effluent from the vapor treatment system will meet South Coast Air Quality Management District (SCAQMD) guidelines, and be tested accordingly.

2.0 CONSTRUCTION OF WELL FIELD AND TREATMENT SYSTEM

2.1 PHASES OF CONSTRUCTION

For the Pemaco project there were four general areas of construction:

- Trench and pipe, extraction wells, and vapor condensate sumps;
- Grading, foundation construction, and treatment building erection;
- Treatment equipment procurement, installation, and system programming; and
- Installation of the ERH system by TRS

2.2 DOCUMENTATION AND DESCRIPTION OF MAJOR PHASES OF CONSTRUCTION

The following section describes the treatment system features according to the major phases of construction. Table 2.2 provides a chronology of construction phases and the subcontractors that completed each phase of work.

The role of TN&A, as the Remedial Action Contractor, was to provide Quality Assurance/Quality Control (QA/QC) during construction, engineering services and consulting, as well as health and safety monitoring. TN&A also self-performed the trench and pipe construction task, as shown on Table 2.2.

As part of TN&A's QA/QC role, daily and weekly Construction Reports were prepared to document:

- Work performed by TN&A and inspection results,
- Work performed by subcontractors,
- Work progress and schedule impacts,
- Task lists and procurement issues, site conditions, and
- Items that impacted the budget.

Appendix 2 contains all of the daily and weekly Construction QC Reports completed by TN&A. In support of the Construction Reports, a photographic record was prepared in Appendix 3 that contains the photographic log of the construction activities.

The USACE was responsible for construction management and oversight for the EPA and the EPA provided final approval for all construction phases. EPA and USACE construction oversight personnel maintained a presence onsite for all phases of construction and worked with TN&A to improve the QA/QC process.

2.2.1 Trenching and Piping

All the Exposition and Perched wellheads are in subsurface vaults; such that, a subsurface network of air supply piping, vapor extraction piping, and groundwater extraction piping had to be constructed. The piping network was installed in a coordinated effort with the construction plans of the City of Maywood's Riverfront Park and the former W.W. Henry property remediation. On behalf of the EPA, TN&A held weekly construction meetings during the trench and pipe task to inform contractors from the City of Maywood and W.W. Henry about subsurface construction activities. Many design conflicts were uncovered during this process, since the area for burying pipelines was limited. In summary, all parties participated in value engineering

concepts, such as sharing trenches whenever possible, and sharing the main electrical transformer.

Details of trench construction and subsurface piping are contained in the Drawings in Appendix 1. Drawings C-2 shows the location of the main extraction piping network. Drawing C -4 shows the trench cross-section detail. Drawing C-5 shows the trench elevation profile.

The piping network for the ERH extraction system, located in the ERH area, was installed above grade by TRS. TN&A provided groundwater extraction, vapor extraction, potable water, and network control stub-ups in the ERH area so that TRS would be able to connect to the treatment system. This allowed the trench and pipe tasks to proceed, while the solicitation process and subsequent technical review of ERH contractors was performed. Pressure testing of the piping was performed before the trenches were backfilled. Results of the pressure test are in the Daily Reports from 2005, Appendix 2.

The completed construction plan (layout) for the ERH system is shown on ERH construction plan and piping layout in Appendix 4. The ERH system is discussed in more detail in Section 4.0.

Because of the potential for higher extraction temperatures of vapors and groundwater from the ERH area, schedule 80 CPVC piping was used for all piping runs that connect to the ERH treatment area. It should be noted that the ERH system does include a vapor-cooling condenser installed by TRS that will reduce vapor temperatures to approximately 15 degrees above ambient air temperatures. Nevertheless, the CPVC piping was installed as a safeguard in the event the condenser fails. The CPVC piping would safely contain any potential vapors until the contingency plan was implemented.

2.2.2 Vapor Condensate Sumps

Vapor from all eight manifolds is routed through a condensate collection system prior to entering the treatment system because of the amount of water extracted from the perched wells, and the high humidity of the air extracted by the vapor extraction system. The condensate collection system consists of eight condensate sumps. Refer to Appendix 1 – Drawings C-10A, C-10B, C-10C, and C-10D for depictions of the condensate sump arrangements. Note that Drawing C-10D shows that four of the sumps were retrofitted with pneumatic pumps, in July 2007, to better handle the average of 10,000 gallons per day of condensate entering the sumps.

2.2.3 Extraction Wells

There are two types of extraction wells designed and installed by TN&A. Appendix 5 contains well tables and drill logs:

1. *Exposition wells:* Construction details and well locations are detailed on Drawing C-3 and C-8, Appendix 1. Each exposition well is equipped with a pneumatic pump capable of pumping 4 to 5 gallons per minute (gpm) to the treatment system; however, the pumps are restricted by the properties of the aquifer to 1 to 3 gpm. Each exposition wellhead has a vacuum gauge, valves for controlling flow, a pump cycle counter, sampling port, and air regulator valve for the pneumatic pump.

   Each exposition well is also connected to the vapor extraction system by a separate PVC line. The ability to extract vapor from each Exposition well is expected to aid in the remediation of the soil above the groundwater table.

2. *Perched wells*: Construction details and locations of the perched wells are detailed on Drawing C-3 and C-6, Appendix 1. Instead of submersible pumps, these wells have "stingers" that rely on the vacuum and flow provided by the liquid ring blowers in the treatment compound. The liquids (contaminated water and some separate-phase contaminates) and vapor extracted from the perched wells are treated at the treatment compound after being separated into either the vapor or liquid phase.

Vaults of the Perched wells contain a section of hose so the drop tube can be adjusted, a vacuum gauge, a sampling port and a valve to control air flow/vacuum.

2.2.4 Additional Vapor Recovery and Electrode Extraction Wells for ERH

Note that in the ERH area, vapor extraction will occur via the vapor recovery and electrode wells. These were installed by Thermal Remediation Systems (TRS), and are described below in Section 4.0 of the CCR.

2.2.5 Grading for the Treatment Building

Sturdi-Quick Prefab Structures (SQ) provided general contracting services for the grading work. Approximately 10,000 square feet was graded for the 4,000 square foot concrete pad (Drawing C-12, Appendix 1). The grading task included over-excavation of the subgrade by approximately 16 inches followed by replacement of the soil after hydrating to optimum moisture content and compaction in 10- to 12-inch lifts. Compaction testing was performed by Twinings Laboratory using nuclear gage methods (ASTM D 2992). The compaction reports are provided in Appendix 6.

The compaction reports show that the relative compaction specification of 95% was met or exceeded in 4 of the 5 tests performed. In summary, the subsurface was graded and compacted in accordance with the specifications to provide a firm base for the concrete foundation.

2.2.6 Foundation Construction and Building for Treatment System

TN&A performed the concrete foundation design and building design so that it could house all the treatment equipment. TN&A's foundation and building design was required in order to obtain bids for the work and also to meet USACE and EPA submittal and contractual requirements; i.e. submittal of the Remedial Design Report. Refer to Drawings C-12, C-13, and C-15B for TN&A's foundation design. Refer to Drawing C-11 for the Treatment Building design and elevations.

SQ provided general contracting services for the procurement of the pre-engineered steel building (provided by Braemar Building Systems) and the foundation structural review (Salsa Steel Corp). The final pre-engineered steel building design drawings and structural calculations were performed by Braemar Buildings, Inc. These submittals are provided in Appendix 7. The Braemar Building design documents were in turn submitted to Salsa Engineering for final structural approval of the concrete foundation. Structural review and engineering approval of the concrete foundation design, including steel reinforcement was performed by Salsa. Their final drawing package is provided in Appendix 7.

As a value engineering step, the preliminary designed building dimensions, column heights, roof height, and wall panel dimensions were evaluated for cost effectiveness when compared to commonly available steel building components at the time of construction. The resulting

exercise kept costs as low as possible, but did result in some structural changes to more commonly available dimensions. For example, two lighter-gauge end columns, on the east and west walls replaced a single heavier gauge center end column. This more economical arrangement allowed for smaller concrete footers and some concrete savings.

Concrete forms were measured and constructed in-place in accordance with the foundation plans. Rebar was cut, tied, and inspected for conformance with ASTM 1615 and ASTM A706 for structural steel reinforcement. The rebar inspection reports are provided in Appendix 6.

Concrete was poured and cured in accordance with the design specifications. As a QC measure, samples of the wet concrete were tested for "slump" and sample rings of poured concrete were measured for compressive strength 4,000 psi for the 28-day curing periods. Twining labs performed all concrete testing and their testing forms are provided in Appendix 6.

In summary, the concrete and structural reinforcement met the requirements as shown on the approved foundation plans (prepared by Salsa) and specifications for steel reinforced concrete. At the time of this report, the foundation is performing very well with no micro-cracks observed.

The final building is a pre-engineered steel structure, 50ft x 80ft, with 12ft high walls and a sloped roof with a pitch of 4/12. The specifications for the building included wind and seismic loading, based on Los Angeles, California building codes and standards. Some features of the building are:

- Two 4'-3" x 7' doors,
- One 12' x 9.5' roll-up door (north side),
- One 13' by 9.5" roll-up door (south side),
- Inside office/storage space and separate electrical room,
- Secondary liquids containment sump and perimeter berm,
- Twin 2 hp ventilation fans and top of wall ventilation mesh, and
- 2-in thick spray-on foam insulation on all side walls.

All treatment equipment, except the cooling tower, refrigerated chiller, and heat exchanger for the FTO fit inside the building as shown on (Drawing M-4, Appendix 1). This arrangement isolates most of the sound inside the building, while saving on building costs by not housing all equipment inside.

2.2.7 Unexpected Delays

SQ was originally contracted to perform foundation grading, concrete f0oundation construction, erection of the steel building, procurement of all materials for construction, and the associated engineering calculations and drawings (stamped by a CA registered engineer) for these tasks.

It became apparent during the grading task that SQ was not capable of meeting the schedule and the requirements of the job. There were several delays related to the initiation of grading for which SQ was put on "Notice". Refer to the August 2, 2006 "Schedule" letter from TN&A to SQ in Appendix 8. SQ was able to complete the grading task satisfactorily, however additional delays were incurred setting concrete forms and tying rebar. The delays and the associated costs are summarized in Pemaco Delay Hour and Cost Summary in Appendix 8. On September 28, 2006, SQ was terminated for convenience. (Refer to Termination for Convenience" letter from TN&A to SQ in Appendix 8.) In Summary, the delays caused by SQ

during construction were primarily incurred between 9/19/06 and 10/27/06. The estimated dollar loss in productivity and re-working the steel grate is summarized in Pemaco Delay Hour and Cost Summary in Appendix 8.

2.2.8 Contractor Change

After SQ was released from the project construction role, Clevenger Construction Co. took over the remaining work for completing the building. Clevenger performed:

- Quality Control inspection of the existing work,
- Improvements for the rebar need for the foundation,
- Corrected the secondary containment trench drain,
- Concrete pouring and curing,
- Erected the pre-engineered building.

All the QC documentation for this work is in Appendix 6.

3.0 SYSTEM COMPONENTS

3.1 TREATMENT SYSTEM OVERVIEW

There are two major components of treatment at Pemaco: Groundwater extracted by the exposition and perched extraction wells; and vapor extracted by the perched, exposition and ERH extraction wells.

Drawings M-1 and M-1A, (Appendix 1) present a process flow diagram for the Site. This section of the Construction Completion Report should be read in conjunction with the as-built drawings in Appendix 1. The as-built drawings include treatment system details, equipment layout, trench location plans, well vault details, piping and instrumentation diagrams and additional system details.

Table 3.1 provides a list that cross-references major equipment by their designation on the PI&D drawings and corresponding vendor data reference.

3.2 WATER EXTRACTION AND TREATMENT

3.2.1 Groundwater Pumps

Groundwater is extracted from 33 wells at the Site using submersible, bottom loading pneumatic, total fluids pumps, identified as P-101A in the drawing package. Each extraction well will have a groundwater flow rate of approximately 1 to 3 gpm. The pump intake is located at the bottom of the pump with an inlet screen allowing groundwater inside the cylinder of the pump. Once the groundwater has filled the pump cylinder, a floating lever actuates a valve to allow compressed air inside the cylinder. The groundwater extraction pumps are manufactured by Clean Environment Equipment, Model Long AP-3/TL.

Compressed air is supplied by a continuous duty air compressor, K-601 in the treatment plant. The compressed air then pushes the extracted groundwater up the discharge tubing through the well vault piping assembly. The groundwater is then pumped to a groundwater booster tank, T - 401.

An air pulse counter, air regulator, pressure gauges and sample ports are located in the well vault at the top of the casing. A typical well vault instrumentation diagram is shown on Drawing M-3, Appendix 1. The compressed air is regulated to approximately 80 pounds per square inch gauge (psig) for pump operation. The air pulse counter records the number of discharge cycles.

3.2.2 Water Treatment

The groundwater treatment system is comprised of a groundwater booster tank, T-401 with a transfer pump, P-401, a 10 micron multiple bag filter housing, F-401 with a single bag filter bypass, F-402, a holding tank, T-402 with a variable speed drive (VFD) transfer pump, P-402 with another set of 10 micron single bag filters, F-403 and F-404 and a two 3,000 lb liquid phase carbon adsorbers, T-403 and T-404. After the carbon adsorbers there is a discharge flow totalizer, FQI-402 and a discharge sampling box, T-405 prior to discharge to the sanitary sewer.

3.3 VAPOR EXTRACTION AND TREATMENT

3.3.1 Vapor Treatment System

The vapor treatment system consists of the following major components:

- A moisture separator, T-101,
- A vapor particulate filter skid, F-101 and F-102,
- Two 75 hp liquid-ring vacuum pumps (LRPs), B-101 and B-102,
- An oil mist filter skid, F-103 and F-104,
- A flameless thermal oxidizer and scrubber skid, FT0-101,
- A flame arrestor, FA-301 to serve as a backflash prevention device from the vapor phase carbon vessels. (The vapor stream is then passed through.),
- Three-stage heat exchanger (vapor conditioning package)
- Vapor phase carbon adsorbers, T-301 and T-302, for polishing treatment.

3.3.2 Description of Vapor Treatment

Soil vapors are extracted from extraction wells using the two LRPs, B-101 and B-102 to provide the vacuum needed. The vapor stream initially passes through a moisture separator, T-101 to remove any entrained water. The separated water is stored in a 500 gallon moisture separator equipped with an auto drain transferred by pump P-501 to the holding tank, T-402. After the moisture separator, T-101, the vapor stream passes through the particulate filters, F-101 and F-102 to remove any particles in the vapor stream. The vapor stream then passes through the LRPs, B-101 and B-102 and the oil mist filters F-103 and F-104, to knock out any oil trapped in the vapor stream from the LRPs. At this point the vapor stream will enter the FTO, if operating in FTO mode, or if the vapor treatment system is operated in carbon bypass mode, the vapor stream will exit the LRPs, bypass the FTO altogether and directly enter the vapor-conditioning package (a three-stage heat exchanger), H-201. The vapor treatment system will only be operated in bypass mode after the FTO is removed from the site or in the event of an emergency shut down of the FTO. In FTO mode the vapor stream enters the FTO for combustion of the VOCs. Natural gas is supplemental fuel for the oxidizer as necessary. The soil vapor from the FTO discharge will pass through a three-stage heat exchanger, H-201 with a vapor-conditioning package.

3.4 TREATMENT SYSTEM UTILITIES

The treatment system consists of the following utility systems to assist in its operation:

- Compressed air system, K-601, T-601, T-602
- Automated Water Pressure Boost System
- Caustic Soda Tank, T-901
- Heat Exchanger, H-401
- Inlet Vacuum Particulate Filters, F-101, F-102
- Oil Mist Filters, F-103, F-104
- Calcium Filter, F-801

- Secondary Containment Sump, P-502
- Natural gas and potable water supply

The O&M contains additional detail of all the system components and manufacturers "cut sheet" for all pieces of equipment.

3.5 SYSTEM CONTROLS

The Site treatment system is designed for continuous automatic operation, while minimizing and detecting the occurrence of alarm conditions. The treatment system is equipped with control devices to detect alarm conditions as they develop and shut the system down until the alarms are acknowledged and cleared. The treatment system uses a System Main Computer (SMC) loaded with programming software for the Programmable Logic Controller (PLC) and SMC. The operation of the treatment system should always provide for the safety of operating personnel and the public as well as the protection of the equipment and the environment.

3.5.1 System Main Computer

The remediation equipment is controlled and monitored by a SMC located in the remediation control room. The SMC provides an interface between the equipment and the operator. This allows the operator to start, stop, reset, change set points, view alarms, and monitor the system, all from the computer. The SMC is configured to data log all process analog signals at 1-minute intervals and also keeps a trend of all the analog channels of the treatment system. The System Control and Data Acquisition (SCADA) system has a built-in auto dialer that will phone or e-mail selected personnel when any alarm occurs.

The alarm history is automatically logged to an alarm log file once per month. The computer is configured with a username and password to prevent unwanted access to the computer.

The control system is fitted with an uninterruptible power supply that will give the PLC and System Main Computer about one hour of run time in the event of a power failure. This allows the system to autodial the necessary personnel that the system went offline.

NOTE: the remediation system will not function in the event of a power failure. The SMC and PLC only stay on for monitoring purposes.

3.5.2 Programmable Logic Controller (PLC)

The SMC communicates via an Ethernet network to the main control panel PLC. The main control panel PLC monitors and controls the physical inputs and outputs (e.g. monitor level switches; turns on pumps) of the system and holds all the logic that controls the system. The logic path for the instrumentation and control system is illustrated on drawings M-1 and M-1A P&ID diagrams, Appendix 1.

3.5.3 Process Control Points & System Alarm Overview

System shutdown and alarm set points are intended to prevent damage to equipment and the discharge of untreated water. When an alarm condition occurs, the red flashing text "ALARM CONDITION" will appear on each screen on the SMC notifying the operator that an alarm condition exists and they must clear the alarm and reset the system. Table 3.5.3 provides completed list of alarm situations. There are several types of alarms that trigger specific system responses:

- *Groundwater Treatment System Warning Alarm*: The groundwater treatment system (GTS) has a process non-critical alarm. When a GTS warning alarm occurs, the alarm is

time and date stamped on the display and sent to the auto dialer for notification. Groundwater system operation is unaffected by a GTS warning alarm.

- *Groundwater System Shutdown Alarm*: The GTS has an alarm that will prevent the system from running within normal parameters. When a GTS Shutdown alarm occurs, all components within the GTS shutdown. The alarm is time and date stamped and sent to the auto dialer for notification. Other vapor treatment system functions are not affected.
- *Vapor Treatment System Warning Alarm*: The vapor treatment system (VTS) has a process non-critical alarm. When the VTS system (Carbon or FTO mode) has a VTS Warning alarm, the alarm is time and date stamped and sent to the auto dialer for notification. VTS operation is unaffected.
- *Vapor Treatment System Shutdown Alarm*: The VTS has an alarm that will prevent the system from running within normal parameters. When a VTS Shutdown alarm occurs, the VTS will perform a normal system shutdown. The alarm is time and date stamped and sent to the auto dialer for notification. Groundwater system functions are not affected.
- *Critical Shutdown Alarm*: A critical condition on the system has occurred and could cause possible equipment damage or flooding. Both treatment systems (GTS and VTS) shutdown immediately. The alarm is time and date stamped and sent to the auto dialer for notification.

3.5.4 Control Panel Indicators

The diaphragm pumps, which pump down the condensate pumps outside the treatment plant, are the only control panel that needs to be operated at the panel. Indicator lights light up when the condensate sumps need to be pumped down. The diaphragm pumps are activated by turning the ball valve and enabling compressed air to the diaphragm pumps. When the condensate sumps are pumped down the indicator lights go out.

All other local control panels should be set for “AUTO” operation.

4.0 ELECTRICAL RESISTIVE HEATING (ERH) SYSTEM

The ERH system was installed by Thermal Remediation Systems (TRS). Refer to Appendix 4 for ERH construction plan and piping layout. The system included aboveground component and subsurface wells as listed below:

- 29 vapor recovery (VR) wells;
- 30 temperature monitoring points (TMP);
- 30 vapor monitoring points (VMP), co-located with the TMPs;
- 58 Electrodes/vapor extraction wells;
- One power control unit (PCU);
- Six (6) Step- Down Transformer and Pads;
- A vapor condenser and cooling tower; and
- All associated piping, cables, instruments and controls.

The treatment plant supplies vacuum for vapor recovery in the ERH area. TRS requires approximately 560 scfm at 12 inches of Hg for all their extraction wells. Control of vapor flow and vacuum can be done by the valve system on the headers and individual wellheads. All soil vapor from the ERH well field will be routed through the condenser prior to entering the vapor condensate sump outside the treatment plant. From there, the vapor treatment is the same as the DPE.

ERH data will be used to make adjustments to power, water injection, and/or extraction systems for optimization of the process. The collection of data includes:

1. Total energy use,
2. Subsurface temperature/thermocouple data,
3. Energy per electrode,
4. Condensate in and out of the condenser, and
5. Water injected into the electrodes; total and individual.

This data along with all other operational data (physical and chemical) will be available to the project managers and operators on the project website.

TRS Equipment Arrival Dates were as follows:

- Power Control Unit: June 8, 2007;
- Water Vapor Condenser: June 8, 2007;
- Cooling Tower: June 8, 2007; and
- Auxiliary Transformers: June 15, 2007.

4.1 AUXILIARY TRANSFORMERS

Thermal Remediation Services, Inc. installed six additional electrical transformer components at the Site. These transformers are distributed within the electrode array and increase the variable range of voltage that can be applied to the subsurface. The inputs of the transformers are connected directly to the Power Control Unit (PCU) maintaining each of the safety and control

features of the PCU. The additional transformers also provide the ability to vary the applied voltage within regions of the treatment volume in response to differences in site lithology.

4.2 INSTALLATION AND ENERGIZING OF STEP-DOWN TRANSFORMER

In order to power the PCU it was necessary to have a “step down” transformer to convert the high voltage (16,000 volt) line to a usable 2000-volt, 1000 amp, three-phase power. The step-down transformer, high-voltage switch gear, and metering was bought by EPA and installed by Southern California Edison (SCE). There were numerous delays by SCE in delivering and energizing this equipment. It was fully operational the week of September 17th, and TRS began full power operation the week of September 24, 2007.

5.0 PROJECT TEAM WEB SITE

The Pemaco project website will serve as a work environment where internal and external participants come together as a cohesive team. All data generated through system monitoring as well as environmental data (e.g. groundwater chemical data, vapor data) will be accessible to the project team via the website. The website will function as a secure virtual office space with all of the tools and facilities necessary for the project team members to stay up to date on developments and to interact with one another.

5.1 DATA COLLECTION AND DATA MANAGEMENT

All field and analytical data collected at the site will be stored permanently in TN&A's Environmental Data Management System (EDMS), a comprehensive SQL Server database hosted on the company intranet behind a secure firewall. Stored data can be exported out of the EDMS in a variety of formats, including Microsoft Access databases, Microsoft Excel spreadsheets, delimited text files, dBase files, and others. The format and structure of these files can be customized to meet the export requirements for nomenclature, data structure, and file size. Exported files can be transferred via e-mail, FTP protocol, written to CD or DVD, or other means depending upon the final size of the file(s).

Integrity of the data stored in EDMS is maintained through software access permissions. The database or domain administrators set access permissions in the SQL Server application. The ability to alter and add data to EDMS is limited to a few trained individuals in the company. Approved individuals are limited to read only access. All non-approved persons (internal and external) are denied any access to EDMS

For the purposes related to the database, the collected data will be classified as either manually recorded or electronically recorded. Each classification of data has a standard procedure for entering the data into the database, as described in the following sections.

5.2 MANUALLY RECORDED DATA

Manually recorded data includes any measurement that is written down or typed into an electronic file by field personnel. Typically these data will include, but not be limited to, water level measurements, pressure/vacuum readings, and flow volumes.

Manually recorded data will be recorded on pre-printed forms (field sheets) in the field and/or directly entered into a formatted electronic spreadsheet. Data recorded on field sheets will then be hand entered into a pre-formatted electronic spreadsheet. The electronic spreadsheet will be imported into the database using a standard query.

5.3 ELECTRONICALLY RECORDED DATA (EDD)

Electronically recorded data (EDD) is any data that is automatically recorded by sensors or laboratory equipment or output by another database and stored electronically. These data are then saved and transferred as an electronic file or EDD. Sources of EDDs are primarily temperature data from the thermocouples and analytical laboratories.

Any entity that will be providing electronic data will be provided specifications for the format of the EDD. These specifications will include definitions for the data columns, data format, valid values, and file format of the EDD. The EDDs will be required to be provided in the specified format. EDDs will be imported into the database using a query specially constructed for each entity.

5.4 DYNAMIC WEB ACCESS TO PROJECT DATA

For security purposes, data stored in the EDMS is only directly accessible to internal (TN&A) project personnel. The project website will access data from a server-hosted database that mirrors the EDMS via a process of automatic synchronization, in which new or updated records in the EDMS are copied over on an hourly basis. Data access will be provided through four customized interfaces:

- Interactive map interface: A web-GIS powered interface for displaying map features (wells, sample locations, etc).
- Interactive schematic interface: A web-GIS powered interface for displaying schematic diagrams (P&ID layouts, etc).
- Database Query Interface: A web-form interface for making direct database queries, resulting in a tabular output.
- Graph-generation Interface: A web-form interface for making direct database queries, resulting in a simple x/y graph output.

5.4.1 Temperature Monitoring Data

Temperature data for the 450 thermocouples deployed at the project site will be provided on a daily basis as an EDD by TRS. The EDD will be imported into the EDMS for permanent storage, and the data will be made available on the project website on a same-day basis via automatic synchronization. From the project website, temperature data may be directly accessed via interactive maps, database query, and dynamically-generated graphs.

5.4.2 Process Data

Process chemical data will be taken from 27 sampling ports, both as field recordings and as lab samples. Process physical data will be taken from 90 locations as field recordings. All process data will ultimately be imported into the EDMS and made available via the project website, where it will be accessible via interactive schematics, database query, and dynamically-generated graphs.

5.4.3 Well Field Data

Well field physical data will be recorded for 218 wells as field recordings. Well field chemical data will be taken for 297 measurements as both field recordings and lab samples. All well field data will ultimately be imported into the EDMS and made available via the project website, where it will be accessible via interactive maps, database query, and dynamically generated graphs.

6.0 ADDITIONAL CONSTRUCTION REQUIRED BY USACE & EPA

Some additional construction was requested by EPA and USACE after construction of the treatment plant and well field were completed by TN&A. Below is a list all of the requested construction elements:

- Solar panels for energy conservation,
- A rod iron security fence around the treatment compound,
- Security system for ERH Area (purchased by TRS),
- Security fence for ERH Area (installation prior to September 1), and
- Additional C-Zone pumping (required a small amount of piping and use of an extra pump that was on site).

All the construction was pre-approved by USACE prior to commencement. Appendix 9 contains scopes of work for solar panel system and rod iron security fence.

6.1 SUPPORTING DOCUMENTATION FOR REMEDIATION

Prior to shake down of the extraction and treatment system TN&A submitted the following draft plans for USACE and EPA review and comment:

- Management and Operation and Maintenance Plan (MOMP),
- Process Hazard Analysis (HazOp),
- Sampling and Analysis Plan (SAP),
- Operation and Maintenance Plan (O&M),
- Emergency Response Plan (ER Plan),
- Environmental Protection Plan (EPP),
- Waste Management Plan (WMP), and
- Accident Prevention Plan and Site Safety Plan (APP/SPP).

6.2 MANAGEMENT AND OPERATION AND MAINTENANCE PLAN

The purpose of this plan is to outline the strategy for optimum operation of the treatment system. The focus of the plan is to describe the responsibilities of the personnel responsible for the operation and acquisition of operational data for the ERH portion of the remediation. Critical portions of the MOMP are:

1. Proper treatment system operation and acquiring the necessary data needed for the ERH remediation,
2. Recording and understanding the goals of the thermal remediation, and
3. The decision process for continued thermal remediation after the thermal targets are met.

After the ERH phase, site activities will significantly change, and subsequently, the operation and data acquisition during operation.

6.3 PROCESS HAZARDOUS ANALYSIS

In order to identify possible hazards steaming from operation of the extraction and treatment equipment, TN&A conducted a Process Hazard Analysis (PHA) for the Pemaco site. The analysis was conducted by AcuTech Consulting Group (AcuTech), a firm that specializes in PHA, with a team of TN&A engineers and the U.S. Army Corp of Engineers (USACE) at the TN&A offices in Ventura, California on January 3 and 4, 2007.

The primary objective of the study was to systematically identify all credible process safety hazards associated with the Pemaco Remediation Site. This included a complete review of the design of the Pemaco Remediation Site, and a focus on process safety hazards versus other occupational safety and health hazards.

A secondary objective was to suggest means to reduce the risks of identified hazards when the team concluded that a recommendation was justified based on risk. Where recommendations were made, the risks of the scenario were evaluated by the team, and prioritized according to a qualitative risk ranking system. The PHA reviewed 151 potential hazard scenarios, and made 47 recommendations for mitigation of hazards. The final PHA (HazOp) report by AcuTech is presented in Appendix A in the Environmental Protection Plan.

6.4 SAMPLING AND ANALYSIS PLAN

The Sampling and Analysis Plan is a detailed and comprehensive plan of all physical and chemical data from the well field and treatment train. The object of the SAP is to ensure the frequency and type of data taken and recorded for health and safety, system operation and maintenance, permit requirements, and the progress of the remediation programs.

6.5 OPERATION AND MAINTENANCE PLAN

The Operation and Maintenance Plan focuses on the extraction and treatment equipment. The O&M Plan identifies all the components of the treatment train; describes the operation of the treatment train, includes the factory specification for all motors, vessels, valves; describes the Process Logic Control (PLC) and alarm system; and includes the as-built drawings for the treatment system.

6.6 EMERGENCY RESPONSE PLAN

The Emergency Response Plan was developed with input from the Community for responses to emergencies such as fire, leaks and spills, odors, etc. The Plan was “ratified at the Community meeting on July 16 2007.

6.7 ENVIRONMENTAL PROTECTION PLAN

This plan describes the engineering control and actions that are part of the treatment system design and operation for mitigating and/or minimizing releases of hazardous materials to the environment. Permit compliance, Emergency Response, System Maintenance, and Communication are major components of the EPP.

6.8 WASTE MANAGEMENT PLAN

The Waste Management Plan describes the types of waste expected from the operation and the method of profiling and disposal of the waste. Types of expected waste include debris, bag filers, granular activated carbon, empty containers, and office waste. Included in this plan are documentation procedures for all non- household/office waste.

6.9 ACCIDENT PREVENTION PLAN AND SITE SAFETY PLAN

This is a safety plan with Activity Hazard Analyses (AHA) specifically written for the operators of the equipment present at Pemaco. This plan augments the Site Safety Plan written by ERM/Jacob & Hefner, which is part of the O&M Plan. The APP/SSP will be the document the site operator's use for tailgate meetings, briefing new site subcontractors, and adding AHAs.

7.0 START UP AND SHAKE DOWN

Shakedown of the treatment system and well field lasted from March 19 to April 23, 2007. The initial 30-day shakedown was conducted by Jacob & Hefner under the direction of ERM. This 30-day period focused mostly on leaks, instruments, PLC controls, FTO start-up, and completing the as-built drawings. There was little effort given to system optimization and problem solving. After the 30-day period, TN&A took over the operation of the treatment system, and began to identify problems that impacted operation of the FTO. Because the FTO is the critical component for vapor treatment, the remediation could not progress until the up-time was improved and a source test for the FTO was successful.

Problems discovered after the 30-day shakedown period, and the remedies, included:

- Excessive sediment in the pumped groundwater, which causes numerous high-level shutdowns of the treatment plant due to the high pressure buildup in the bag filter system. Changing the filter to a larger size resulted in sediment buildup in the liquid phase GAC. The solution to this problem was cutting back on the groundwater extraction, vacuum applied to the Exposition wells, and a design for backwashing the GAC.
- Algae buildup in the holding tanks, which also led to clogging the bag filters, and shutting down the treatment plant. A chemical maintenance plan was implemented, and a chlorine feed system was designed and installed.
- Excess heat in the FTO, which was caused by uneven flow and/or vacuum in the header system. A modification to pump more groundwater from the sump was implemented along with the installation of four pneumatic pumps with level controls. By keeping the level of water low in this sump, it allowed a more even flow of air, and better up-time for the FTO.
- Sediment buildup in downhole pumps caused pump shutdown. Seven pumps were pulled, valves replaced, and the placement of the pumps was several feet higher in the well.
- Tank T-101 collapsed during testing, because it could not withstand the vacuum. TN&A specified the tank needed to be operational at approximately 29 in. of Hg of vacuum. This tank was covered by warrantee, and a replacement tank was ordered by ERM. The replacement tank showed signs of stress under operation, and was modified by welding a steel “belt” around the tank (among other welding) for reinforcement.
- During emptying of the liquid GAC Tank T-403 and T-404, the fitting attaching the screen/filter to the tank side wall sheared-off under its own weight plus the carbon, at the point where it connects to the tank side wall. The shear point was caused by the cantilevered screen section with no under-support. The fittings were Schedule 40, not Schedule 80 as shown in the Tank Design Drawing. The broken Schedule 40 fittings were repaired and replaced with Schedule 80 fittings.
- B-101 and B-102 Dekker Liquid Ring pumps continued oil blow-by to the FTO. This issue incurred FTO high temperature alarms and caused the vapor treatment system to shutdown. As a remedy, six (6) oil scavenge/return lines were installed from F-103, F-104 oil mist filters, and several locations downstream of the oil mist filters, to the

vacuum pumps. A leaking Dekker filter was replaced and additional filter inserts were installed in F-103 and F-104 to remedy the oil issue.

- The potable water booster pump VFD and P-402 VFD were reporting high voltage errors that are believed to have been caused by SCE voltage spikes. The errors would occasionally shut down these pumps without notice, sometimes causing a plant shutdown. To attenuate the voltage spikes, line reactors were installed at both locations, thereby eliminating the high voltage errors.
- Groundwater tank high or low level alarms would shut off the air compressor, rendering the double diaphragm pumps for the vapor treatment system inoperable. Installed stand-alone compressed air line from air compressor tank to double diaphragm pumps. It is required to keep double diaphragm pumps operating after GW system shuts down, such as during GW tank High-High alarm.
- Unidentified T-402 High-High alarm incurred during the operation and caused the groundwater treatment system shutdown. Raising the LSHH-402 High Level on T-402 was the remedy for this situation. This remedy also created additional tank holding capacity.
- Alzeta/Anguil were asked to the site on two occasions to inspect and optimize the gas control valve settings, burner temperature, check influent vapor pressure alarms, adjust quench chamber spray nozzles, and replace quench chamber insulation and repair a weld. To facilitate FTO operation, TN&A installed a barometric damper, vacuum gage, and pressure shut-off switch, and added a PLC interlock and various other PLC programming to allow the FTO to operate in tandem with the vapor conditioning package.
- There were constant adjustments to all the level controls and alarm switches for all tanks, vessels and motors in the treatment plant. All the programming was done by Aspect Electrical Engineering & Service, LLC lead programmer, Mike Ebner, working with the TN&A engineers.

Table 7.0 displays the changes made to the original design that solved these problems. In addition, the 60+ day shakedown period allowed TN&A to develop protocols for operation and maintenance, and identify any AHA that was not part of the initial Site Safety Plan.

8.0 FUTURE DOCUMENTATION

This CCR is being provided to document the elements of the remedial construction for the Pemaco site. Additional documentation will include the following reports.

Real-time Web Site Reporting – This is described previously in Section 5.0. The web site is an extremely powerful tool for tracking thermal remediation and analysis of the progress of heating and mass removal. In addition, the ability to make daily adjustments to the extraction and/or ERH system to optimize the remediation is critical to the daily expense of operation.

Interim Progress Reports – Weekly and monthly progress reports are planned for the duration of the ERH phase of remediation. These reports will document the progress of the heating and extraction to determine if the project goals of are being met and how long heating should continue after the temperature targets are met. Graphs of temperature versus mass removal versus energy input will be generated using the "real time" database. Most critical operational parameters such as pumping rates, contaminant trends, and extraction rates will rely on the graphs and images generated by the graphic/database developed for the web site. Monthly reports will contain an operational narrative and more details and analysis than the weekly reports.

Interim Remedial Action Construction Reports (i-RACR) – The i-RACR is a document that demonstrates the remedy for the Operational Unit (OU) has been constructed and operating successfully. The CCR, properly amended with all the additional construction during the shake-down period should be sufficient for demonstrating construction is complete. The monthly reports may suffice for demonstrating the successful operation of the remedy. Prior to submitting the i-RACR, an outline will be submitted to the EPA and USACE for acceptance.

Remedial Action Construction Reports (RACR) – The RACR is a document that demonstrates the remedial action objectives have been met for the last OU, and thus remedies for all the OUs at an installation have been completed, and all remedial action objectives have been met. Because there are several remedies at Pemaco (ERH, bioremediation, DPE); and each has a different timeline, there may be several RACRs for the project.

Tables

TABLE 2.2. CHRONOLOGY OF CONSTRUCTION PHASES AND SUBCONTRACTOR LIST

Item #	Task	Start	Complete	Subcontractor	Note
1	Subsurface Piping	8/1/2005	10/12/2005	TN&A	
2	Well Drilling	8/15/2005	10/5/2005	Gregg Drilling	
				ABC Liovin Drilling	
3	Well Vault & Plumbing	9/15/2005	11/21/2005	TN&A	
4	EPA Design Review of ERH	12/1/2005	7/1/2006	Team of USACE, EPA, and industry experts	
5	Building Foundation & Exterior Equip Pads	8/3/2006	10/23/2006	Sturdi-Quick Prefabricated Structures	See Note 1
				Clevenger Construction	
6	Building Erection	10/24/2006	12/1/2006	Clevenger Construction	
7	Equip. Procurement/Installation/Plumbing	9/8/2006	3/2/2007	ERM/MK Environmental/Innovative Construction Solutions	See Note 2
8	FTO Delivery	1/29/2007	1/29/2007	Anguil Environmental Systems	
9	Electrical & Control System Installation	12/4/2006	3/2/2007	ERM/Jeffries Electric	See Note 2
10	PLC	2/27/2007	3/15/2007	ERM/Aspect Electrical Engineering & Service	See Note 2
11	30-Day Shakedown	3/19/2007	4/23/2007	ERM/Jacob & Hefner Associates	See Note 2

Note:

1. Sturdi-Quick was terminated for convenience on 9/28/06 based on poor performance: could not meet scheduling demands, were using lower quality subcontractors, and were not able to generate USACE required reporting documents in a timely or effective manner.
2. The notation indicates ERM was prime subcontractor for this task.

TABLE 3.1 - PEMACO MAJOR EQUIPMENT LIST

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Design Specified Manufacturer Catalog	"As-Built" Specified Manufacturer Catalog	Other Specifications
B-101	Liquid-Ring Vacuum Pump System	Skid: 78"x73" Inlet: 8"/Outlet: 8"	TYP	75 HP/1100 ACFM	Oil-Sealed 75 hp Dekker Vacuum Technologies, Inc. System Model #VMX1103KA1-01	SAME VMX1103KA1-01	Equipped with oil liquid ring, system interlock/failsafe, alarms, and hour meters. Max. vac. 29"Hg. 1100 RPM. Max. noise level: 80 dBA. See Table 4-12 - Major Equipment Specifications for more details.
B-102	Liquid-Ring Vacuum Pump System	Skid: 78"x73" Inlet: 8"/Outlet: 8"	TYP	75 HP/1100 ACFM	Oil-Sealed 75 hp Dekker Vacuum Technologies, Inc. System Model #VMX1103KA1-01	SAME VMX1103KA1-01	Equipped with oil liquid ring, system interlock/failsafe, alarms, and hour meters. Max. vac. 29"Hg. 1100 RPM. Max. noise level: 80 dBA. See Table 4-12 - Major Equipment Specifications for more details.
B-301	System Exhaust Blower with Sound Enclosure	Skid: 72.5"Wx42"Lx59"H, Inlet: 8"/Outlet: 8"	TYP	1,000 CFM, 25 HP	Design/Build	Baldor EM4103T - 25 HP Motor, Roots Rotary Positive Blower - Frame Size 615, SDY 54-106-AA Silencer	25 HP, 1770 RPM, TEFC, 1036 CFM @ 1750 RPM, 7 psi. See Submittal 11215-16 for sound enclosure details.
CT-201	Cooling Tower, VC Package	156-1/8" D x 160-5/8" H	TYP	650 GPM	Design/Build	AQUA-Loop Cooling Tower MB-300	To be provided as part of the vapor conditioning package. Water evaporation rate: 7.0 gpm. Water blowdown rate: 3.0 gpm. Total water consumption rate is estimated to 10.0 gpm.
CV-401, 402	Bypass Control Valves	8"	CPVC SCH80	Rated for 15 psig, 200° F	Hayward Manual Butterfly Valve Engineer Approved Equivalent		Flanged Butterfly valve with Viton elastomer
D-601	Regenerative Desiccant Dryer	23"L x 7"W x31"H	TYP	5 SCFM, 90 PSIG, -90°F Dew Point	KAESER KADW-10	SAME KAESER KADW-10	To provide continuous 5 scfm, 90 psig, and -90°F dew point purge air to FTO, Regenerative desiccant type
dPIT-101	Differential Pressure Indicating Transmitter	Not Specified	Stainless Steel	0-10" WC	Dwyer Instrument Model# 605-6	Dwyer Instrument Model# 605-10	Electrical accuracy ±0.5%, mechanical accuracy ±2%, 4-20 mA, 2 wire, 10-35 VDC, 0-10" WC, stainless steel connection tubing
F-101	Inlet Vacuum Particulate Filter	26-7/16"D x 69-1/2"H (Skid: 72"W x 48"L x 4"H)	Stainless Steel	5 Microns/2000 ACFM	Solberg CSL Series	SAME CSL-485P(2)-1200FS1 485P Polyester Element	99%+ removal efficiency, Inlet air enters canister above element, SS Housing cartridge filter, Positive sealing O-ring seal system, 0.5 bar pressure for vacuum tightness, Vacuum level: $1x10^{-3}$ mmHg. Two filters installed in parallel with valving as shown in Drawing M-4. Nominal Rating: 4950 SCFM, two (2) 485P elements per filter housing. 6" inlet/outlet are custom welded.
F-102	Inlet Vacuum Particulate Filter	26-7/16"D x 69-1/2"H (Skid: 72"W x 48"L x 4"H)	Stainless Steel	5 Microns/2000 ACFM	Solberg CSL Series	SAME CSL-485P(2)-1200FS1 485P Polyester Element	99%+ removal efficiency, Inlet air enters canister above element, SS Housing cartridge filter, Positive sealing O-ring seal system, 0.5 bar pressure for vacuum tightness, Vacuum level: $1x10^{-3}$ mmHg. Two filters installed in parallel with valving as shown in Drawing M-4. Nominal Rating: 4950 SCFM, two (2) 485P elements per filter housing. 6" inlet/outlet are custom welded.
F-103	Oil Mist Exhaust Filter	18-1/2"D x 38-1/8" H (Skid: 72"W x 48"L x 4"H)	Stainless Steel	0.3 Microns/1100 SCFM	Solberg HDL Series	SAME HDL-PSG474-2-500	0-5 PSIG operating, 10 PSIG proof pressure, Minimum 99.97% D.O.P. on 0.3 um diameter particles, Positive sealing O-ring seal system, SS Housing cartridge filter. Two filters installed in parallel with valving as shown in Drawing M-4.
F-104	Oil Mist Exhaust Filter	18-1/2"D x 38-1/8" H (Skid: 72"W x 48"L x 4"H)	Stainless Steel	0.3 Microns/1100 SCFM	Solberg HDL Series	SAME HDL-PSG474-2-500	0-5 PSIG operating, 10 PSIG proof pressure, Minimum 99.97% D.O.P. on 0.3 um diameter particles, Positive sealing O-ring seal system, SS Housing cartridge filter. Two filters installed in parallel with valving as shown in Drawing M-4.
F-401	Water Filter, Four (4) size two bag filter housings in one vessel	22" D x 68" H (Skid: 60"W x 30"L x 4"H)	316 Stainless Steel	400 GPM	Hayward/Eaton Filtration, LLC. Qic-Lock™ Maxiline™ VMBF SE # VMBF-0402-AB10-040A-UT-11SE	SAME VMBF-0402-AB10-040A-UT-11SE	Multiple 316 SS bag filter with (4) size two bag filter housings inside one vessel, spring assisted cover, 4" flanged inlet/outlets, low profile for quick filter replacement. Mounted on skid with single bag filter F-402. Inlet/outlet shut-off valves as shown in Drawing M-4.
F-402	Water Filter, One (1), size two bag filter housing	13.44"D x 41.25"H	316 Stainless Steel	180 GPM	Hayward/Eaton Filtration, LLC. Flowline™ FBF-0102-AB10-020A	Krystil Klear Filtration L88302FB610, 100 psi	Single 316 SS bag filter with (1) size two bag filter housing, 2" flanged inlet/outlets, low profile for quick filter replacement. Mounted on skid with multiple bag filter housing F-401. Shut-off valves as shown in Drawing M-4.
F-403	Water Filter, size two bag filter housing	13.44"D x 41.25"H	316 Stainless Steel	180 GPM	Hayward/Eaton Filtration, LLC. Flowline™ FBF-0102-AB10-020A	Krystil Klear Filtration L88302FB610, 100 psi	Single 316 SS bag filter with size two bag filter housing, 2" flanged inlet/outlets. Skid mounted. Shut-off valves as shown in Drawing M-4.
F-404	Water Filter, size two bag filter housing	13.44"D x 41.25"H	316 Stainless Steel	180 GPM	Hayward/Eaton Filtration, LLC. Flowline™ FBF-0102-AB10-020A	Krystil Klear Filtration L88302FB610, 100 psi	Single 316 SS bag filter with size two bag filter housing, 2" flanged inlet/outlets. Skid mounted. Shut-off valves as shown in Drawing M-4.
F-501	Water Filter, size two bag filter housing	13.44"D x 41.25"H	316 Stainless Steel	180 GPM	Hayward/Eaton Filtration, LLC. Flowline™ FBF-0102-AB10-020A	Krystil Klear Filtration L88302FB610, 100 psi	Single 316 SS bag filter with size two bag filter housing, 2" flanged inlet/outlets. Skid mounted. Shut-off valves as shown in Drawing M-4.

TABLE 3.1 - PEMACO MAJOR EQUIPMENT LIST

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Design Specified Manufacturer Catalog	"As-Built" Specified Manufacturer Catalog	Other Specifications
F-502	Water Filter, size two bag filter housing	13.44"D x 41.25"H	316 Stainless Steel	180 GPM	Hayward/Eaton Filtration, LLC. Flowline™ FBF-0102-AB10-020A	Krystil Klear Filtration L88302FB610, 100 psi	Single 316 SS bag filter with size two bag filter housing, 2" flanged inlet/outlets. Skid mounted. Shut-off valves as shown in Drawing M-4.
F-601	Air Filter-compressed air particulate filter with automatic drain	1 1/2" NPTF	Aluminum	250 cfm @ 100 psig	Kaeser KPF-250	SAME Kaeser KPF-250	Maximum working pressure: 250 psig. Maximum operating temp: 150°F.
F-801	Calcium Filter	108"x31.5"x74"	TYP	20 GPM min/<3ppm Calcium	U.S. Filter KF Series KFZSDO21FPZVBX	U.S. Filter Duplex KF-2 21"x62" KFZSDO21FPZVCX	US Filter KF Series Duplex Alternating Softener w/ brine tank, Feed Temp 45-100°F, Feed pressure 30-100 psig, <3ppm Calcium, 77 GPM, 110V
FA-301	Flame Arrestor	12.72"OD x 6.88"W, 55 lbs	Aluminum outer body with 316 SS internal	Not Specified	Design/Build	GROTH Model 80013075	Flame arrestor to serve as a backflash prevention device (from vapor phase carbon vessels). Aluminum outer body with 316 SS internal, 12.72" OD, 55 lbs.
FE-101	Vapor Flow Element-Averaging Pitot Tube	Not Specified	Sensor Tube - 304 SS	0-3040 SCFM	Dywer DS-300-8"	SAME Dywer DS-300-8"	Averaging pitot tube to be used with differential pressure transmitter (dPIT-101), valve is rated at 200 psig and 200°F, 1/4" NPT connection.
FI-101 to 108	Vapor Flow Indicator	1/4" NPT	Brass	Not Specified	Swagelock Borethrough B-500-1-4BT with Plug (B-500-P)	B-500-1-4	1/4" NPT borethrough fitting for insertion of averaging pitot tube.
FQI-401	Flow Totalizer & Indicator	Inlet: 3"/Outlet: 3"	PVDF Rotor, PVC SCH80 TEE	22-450 GPM	Signet Series 515 Rotor X, Signet Series 8550 ProcessPro Flow Transmitter, Signet Installation Fitting 3" Tee	SAME	Self-powered flow sensor, housing material PVDF, rotor material nat. PVDF, pipe size 1/2" to 4" <Harrington Plastics Part# PS1530-V0>, Field mount with dual input/output <Harrington Plastics Part# 3-8550-3>, 4-20mA, 24 VDC power, <Harrington Plastics Part# PV8T030>, Accurancy: +/- 0.5%.
FQI-402	Flow Totalizer & Indicator	Inlet: 2"/Outlet: 2"	Brass	2.5-160 GPM	McMaster-Carr 3786k96	SAME	Corrosion-Resistant totalizer with Impeller, NPT male connection. Accurancy: +/- 1.5%.
FQI-501	Flow Totalizer & Indicator	Inlet: 2"/Outlet: 2"	PVDF Rotor, PVC SCH80 TEE	20-200 GPM	Signet Series 515 Rotor X, Signet Series 8550 ProcessPro Flow Transmitter, Signet Installation Fitting 2" Tee	SAME	Self-powered flow sensor, housing material PVDF, rotor material nat. PVDF, pipe size 1/2" to 4" <Harrington Plastics Part# PS1530-V0>, Field mount with dual input/output <Harrington Plastics Part# 3-8550-3>, 4-20mA, 24 VDC power, <Harrington Plastics Part# PV8T020>, Accurancy: +/- 0.5%.
FTO-101	Flameless Thermal Oxidizer and Scrubber	Skid: 8'x30'	Not Specified	1000 SCFM Max.	Not Specified	ANGUIL EDGE QR-1000	To be provided by Anguil and procured by USACE
H-201 A/B/C	Air Chiller/Condenser	149"x40"x45-5/8"	Stainless Steel/Zinc Plated Steel	297 GPM	Design/Build	Xchanger Model TV-275	The VC Package must be capable of interfacing with both the FTO PLC and treatment compound PLC. 297 GPM, Design Temp: -100°F to 225°F.
H-202	Air Warmer	19-11/16" Dia x 3" H	Stainless Sheaath and Fins	Not Specified	Design/Build	Vulcan VFT612-10C3 Low Temp Duct Heater	The VC Package must be capable of interfacing with both the FTO PLC and treatment compound PLC. Inlet air temperature shall not exceed 100°F.
H-401	Heat Exchanger	Inlet: 2"/Outlet: 2"	Stainless Steel/Copper coils	20 GPM	Xchanger, Inc. LC series or equivalent	SAME Xchanger LC-24-2	See Table 4-12 Major Equipment Specifications for more details. Temperature in: 165°F, Temperature out: 130°F. Pressure loss: 2.1 psi. Design temperature: -300 to 200°F.
K-601	Rotary Screw Air Compressor and receiver tank	45" x 33" - compressor, 30" Dia receiver	TYP	125 PSI, 124 SCFM, 30 Hp, 240 Gallon receiver	Kaeser Compressor AS-30	SAME Kaeser Compressor AS-30	See Table 4-12 - Major Equipment Specifications for more details.
LI-101	Level Indicator	Not Specified	Clear PVC	Not Specified	Design/Build	MK Environmental Stilling Well Level Control Typical	Level indicator for moisture separator to consist of clear pipe with valves and flanges/unions to allow for replacement/cleaning of indicator
LI-201	Level Indicator	Not Specified	Clear PVC	Not Specified	Design/Build	MK Environmental Stilling Well Level Control Typical	Level indicator for moisture separator to consist of clear pipe with valves and flanges/unions to allow for replacement/cleaning of indicator
LI- 401	Level Indicator	Not Specified	Clear PVC	Not Specified	Design/Build	MK Environmental Stilling Well Level Control Typical	Level indicator for moisture separator to consist of clear pipe with valves and flanges/unions to allow for replacement/cleaning of indicator
LI-402	Level Indicator	Not Specified	Clear PVC	Not Specified	Design/Build	MK Environmental Stilling Well Level Control Typical	Level indicator for moisture separator to consist of clear pipe with valves and flanges/unions to allow for replacement/cleaning of indicator

TABLE 3.1 - PEMACO MAJOR EQUIPMENT LIST

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Design Specified Manufacturer Catalog	"As-Built" Specified Manufacturer Catalog	Other Specifications
LI-901	Level Indicator	Not Specified	Clear PVC	Not Specified	Design/Build	Poly Processing Co. Float Type Sight Gage	Level indicator for caustic tank. Mechanical gauge mounted onto the top of the double contained caustic tank.
LSH-101	Level Switch High	Not Specified	Stainless Steel	Not Specified	W.E. Anderson Flotect® Series L6 with stainless steel float	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSH-201	Level Switch High	Not Specified	Stainless Steel	Not Specified	Design/Build	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSH-401	Level Switch High	Not Specified	Stainless Steel	Not Specified	W.E. Anderson Flotect® Series L6 with stainless steel float	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSH-501	Level Switch High	Not Specified	Stainless Steel	Not Specified	Dwyer F7-MQ Series Multi-Station Level Switch or Engineer approved equivalent.	GEMS Stainless Steel Multilevel Float Switch - LS800-3-BR-SS-SPST-20-GR2-3	Plumbing and electrical configured for quick removal for cleaning/replacement, 316 SS, SS ARMCO PH-15-7MO Grip Rings, -40 to 300°F.
LSHH-101	Level Switch High-High	Not Specified	Stainless Steel	Not Specified	W.E. Anderson Flotect® Series L6 with stainless steel float	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSHH-201	Level Switch High-High	Not Specified	Stainless Steel	Not Specified	Design/Build	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSHH-401	Level Switch High-High	Not Specified	Stainless Steel	Not Specified	W.E. Anderson Flotect® Series L6 with stainless steel float	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSHH-402	Level Switch High-High	Not Specified	Stainless Steel	Not Specified	W.E. Anderson Flotect® Series L6 with stainless steel float	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSHH-501	Level Switch High-High	Not Specified	Stainless Steel	Not Specified	Dwyer F7-MQ Series Multi-Station Level Switch or Engineer approved equivalent.	GEMS Stainless Steel Multilevel Float Switch - LS800-3-BR-SS-SPST-20-GR2-3	Plumbing and electrical configured for quick removal for cleaning/replacement, 316 SS, SS ARMCO PH-15-7MO Grip Rings, -40 to 300°F.
LSL-101	Level Switch Low	Not Specified	Stainless Steel	Not Specified	W.E. Anderson Flotect® Series L6 with stainless steel float	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSL-201	Level Switch Low	Not Specified	Stainless Steel	Not Specified	Design/Build	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSL-401	Level Switch Low	Not Specified	Stainless Steel	Not Specified	W.E. Anderson Flotect® Series L6 with stainless steel float	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSL-501	Level Switch Low	Not Specified	Stainless Steel	Not Specified	Dwyer F7-MQ Series Multi-Station Level Switch or Engineer approved equivalent.	GEMS Stainless Steel Multilevel Float Switch - LS800-3-BR-SS-SPST-20-GR2-3	Plumbing and electrical configured for quick removal for cleaning/replacement, 316 SS, SS ARMCO PH-15-7MO Grip Rings, -40 to 300°F.
LSL-901	Level Switch Low	Not Specified	316 Stainless Steel	Not Specified	Dwyer/W. E. Anderson Series F7 Vertical Level Switch	Dwyer/W. E. Anderson Series F7-ST713 Vertical Level Switch	Vertical Level Switch installed from the top of the double contained tank. Float material must be chemically compatible with 25% NaOH solution.
LSLL-401	Level Switch Low-Low	Not Specified	Stainless Steel	Not Specified	W.E. Anderson Flotect® Series L6 with stainless steel float	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
LSLL-402	Level Switch Low-Low	Not Specified	Stainless Steel	Not Specified	W.E. Anderson Flotect® Series L6 with stainless steel float	W.E. Anderson Flotec® Series L6 L6EPBBS3A	Plumbing and electrical configured for quick removal for cleaning/replacement, -4 to 220°F, Explosion proof, SPDT switch type, 1" NPT, 304 SS Cylindrical Float.
P-201	Cooling Tower Transfer Pump	35.85" x 15.75"	Stainless Steel	Not Specified	Design/Build	SCOT ARDOX Motorpump - 1750 RPM, 20 HP, 9.38" Impeller, TEFC	To be provided as part of the vapor conditioning package.
P-202	Refrigerated Chiller Pump	18-5/16"x8.5"x8-3/4" (LxWxH)	Stainless Steel	Not Specified	Design/Build	ITT Goulds Pump - 2ST1H5B4, 3 HP, TEFC Motor	To be provided as part of the vapor conditioning package.

TABLE 3.1 - PEMACO MAJOR EQUIPMENT LIST

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Design Specified Manufacturer Catalog	"As-Built" Specified Manufacturer Catalog	Other Specifications
P-203	VC Package Condensate Pump	Skid: 19.5"Wx20"Lx3.5"H	Polypropylene, ETFE	52 GPM/45' TDH	Design/Build	Pacer Pumps - Z-40, 1/2 HP	To be provided as part of the vapor conditioning package
P-401	Booster Tank Pump	Skid: 19.5"Wx15"Lx3.5"H	316 Stainless Steel	110 GPM/55' TDH/3 Phase, 460 V	Design/Build	ITT Goulds Pump - 2ST1H2B4, 3 HP, ODP Motor	Centrifugal pump see Major Equipment Specifications for more details. The pump may pass no more than 3/16" particle.
P-402	Holding Tank Pump	Skid: 19.5"Wx16"Lx3.5"H	316 Stainless Steel	100 GPM/75' TDH/3 Phase, 460 V	Design/Build	ITT Goulds Pump - 2ST1JSA4, 5 HP, ODP Motor	Centrifugal pump see Major Equipment Specifications for more details. The pump may pass no more than 3/16" particle.
P-501	Transfer Pump	Skid: 20"Wx19"Lx3.5"H	316 Stainless Steel	30 GPM/75' TDH/3 Phase, 460 V	Design/Build	AMT Self-Priming Centrifugal Pump 282B-98	Self priming centrifugal see Major Equipment Specifications for more details. The pump can handle 3/8" diameter semi-solids.
P-502	Pump for Secondary Containment Sump	TYP	316 Stainless Steel	30 GPM/35' water/3 Phase, 460 V	Design/Build	Dayton Submersible Sewage Pump DN2110070T	Submersible sump pump, solid handeling, self priming. Equipped with LSL, LSH, LSHH, system interlock, and alarms.
P-901	Metering Pump	Skid: 15.25"Wx8"Lx3.5"H	TYP	34 GPH @ 1725 RPM	Provided by Anguil.	MacRoy Pump D7688PE1NIN	Provided by Anguil and installed by the contractor.
PI-101 to 103, 201 to 203, 414	Air Pressure Indicator	TYP	304 SS Case/316 SS Internal	0-15 PSI	Not Specified	McDaniel Controls K9A-GF (0-15 psi)	2-1/2" Dial Glycerin-Filled, Grade 1A, 1/4" Bottom NPT male connection
PI-401 to 405, 407, 408, 501, 502	Water Pressure Indicator	TYP	304 SS Case/316 SS Internal	0-60 PSI	Not Specified	McDaniel Controls K9C-GF (0-60 psi)	2-1/2" Dial Glycerin-Filled, Grade 1A, 1/4" Bottom NPT male connection
PI-406, 409 to 413, 415, 503, 504	Water Pressure Indicator	TYP	304 SS Case/316 SS Internal	0-30 PSI	Not Specified	McDaniel Controls K9B-GF (0-30 psi)	2-1/2" Dial Glycerin-Filled, Grade 1A, 1/4" Bottom NPT male connection
PI-601	Air Pressure Indicator	TYP	316 Stainless Steel	0-200	Not Specified	Kodiak Controls Glyrcerine Filled, 2-1/2-in Dial Size, SS316, Model KC301L Pressure Indicating Gauge (0-200 psi)	2-1/2" Dial Glycerin-Filled, 1.5% Accurancy, 1/4" Bottom NPT male connection
PI-602	Air Pressure Indicator	TYP	304 SS Case/316 SS Internal	0-160	Not Specified	McDaniel Controls K9E-GF (0-160 psi)	2-1/2" Dial Glycerin-Filled, Grade 1A, 1/4" Bottom NPT male connection
PRV-401, 402, 403, 404, 901, 902	Pressure Relief Valve	Not Specified	Not Specified	Not Specified	Not Specified	Poly Processing Co. 2" Mushroom (PPL) Relief Valve with Viton Seals	T-401 has (3) 2" vents. T-402 has (2) 2" vents. T-901 has (3) 2" vents.
PRV-405	Pressure Relief Valve	Not Specified	Not Specified	Not Specified	Not Specified	McMaster-Carr #4780K16, 2", set at 65 psi	PRV-406 is not necessary as PRV-405 will be mounted on the inlet manifold to T-403 and T-404 and will serve both tanks adequate pressure and flow should be maintained down stream of valve.
PRV-101, 301, 303	Pressure Relief Valve	Not Specified	Not Specified	Not Specified	Not Specified	Kunkle Model 337 #0337-H01ANE0005	2", set point 6 psig.
PRV-602	Pressure Relief Valve	Not Specified	Not Specified	Not Specified	Not Specified	Control Devices, Inc. SF50	Set point 140 psi, capacity 257 SCFM
PS-601	Pressure Switch	TYP	Stainless Steel	22.5-125 PSI	McMaster# 46995K17	McMaster# 46995K18, 22.5-125 psi, Nema 4	Compact cylindrical pressure switch, Nema 4, 1/2" NPT male, 5A @ 125/250 VAC, Buna - N diaphragm - sealed piston, set point range 22.5-125 psi, SPDT
PT-101	Air Pressure Transmitter	TYP	Stainless Steel	0-5 PSI	Dwyer Instrument Model# 673-3C	Dwyer Instrument Model# 673-3C, 0-5 psi	±0.25% full span accuracy, 17-4 PH SS, 4 to 212°F, 4-20 mA, 2 wire, 0-15 psi
PT-401	Water Pressure Transmitter	TYP	316 Stainless Steel	0-60 PSI	McMaster# 3196K1	McMaster# 3196K1, 0-60 psi	Economy transducer, 1/4" NPT male, 316 SS, -40 to 212°F, ≤ 0.5% accuracy, 10-30 VDC, 2 wire, 4-20 mA
PT-402	Water Pressure Transmitter	TYP	Stainless Steel	0-5 PSI	Dwyer Instrument Model# 673-3C	Dwyer Instrument Model# 673-3C, 0-5 psi	±0.25% full span accuracy, 17-4 PH SS, 4 to 212°F, 4-20 mA, 2 wire, 0-5 psi

TABLE 3.1 - PEMACO MAJOR EQUIPMENT LIST

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Design Specified Manufacturer Catalog	"As-Built" Specified Manufacturer Catalog	Other Specifications
PT-403	Water Pressure Transmitter	TYP	316 Stainless Steel	0-60 PSI	McMaster# 3196K1	McMaster# 3196K1, 0-60 psi	Economy transducer, 1/4" NPT male, 316 SS, -40 to 212°F, ≤ 0.5% accuracy, 10-30 VDC, 2 wire, 4-20 mA
PT-404	Water Pressure Transmitter	TYP	316 Stainless Steel	0-60 PSI	McMaster# 3196K1	McMaster# 3196K1, 0-60 psi	Economy transducer, 1/4" NPT male, 316 SS, -40 to 212°F, ≤ 0.5% accuracy, 10-30 VDC, 2 wire, 4-20 mA
PT-501	Water Pressure Transmitter	TYP	316 Stainless Steel	0-60 PSI	McMaster# 3196K1	McMaster# 3196K1, 0-60 psi	Economy transducer, 1/4" NPT male, 316 SS, -40 to 212°F, ≤ 0.5% accuracy, 10-30 VDC, 2 wire, 4-20 mA
R-601	Air Regulator	8.07" x 4.25"	TYP	5-125 psi	McMaster# 4959K57	McMaster# 4959K57	1 1/2" NPTF, Maximum scfm @ 100 psi: 440 scfm
R-602	Air Regulator	7.64" x 3.15"	TYP	10-250 psi	McMaster# 4959K54	McMaster# 4959K54	3/4" NPTF, Maximum scfm @ 100 psi: 220 scfm
R-603	Air Regulator	8.07" x 4.25"	TYP	5-125 psi	McMaster# 4959K55	McMaster# 4959K55	1" NPTF, Maximum scfm @ 100 psi: 480 scfm
R-604	Air Regulator	8.07" x 4.25"	TYP	5-125 psi	McMaster# 4959K55	McMaster# 4959K55	1" NPTF, Maximum scfm @ 100 psi: 480 scfm
R-605	Air Regulator	8.07" x 4.25"	TYP	5-125 psi	McMaster# 4959K55	McMaster# 4959K55	1" NPTF, Maximum scfm @ 100 psi: 480 scfm
R-606	Air Regulator	8.07" x 4.25"	TYP	5-50 psi	Not Specified	McMaster# 4959K55	1" NPTF, Maximum scfm @ 100 psi: 480 scfm
RC-201	Refrigerated Chiller, VC Package	10'-8"x5'-4"x4'-4" (LxWxH)	Copper Tube/Aluminum Fin	25 Ton/300,000 Btu/Hr	Design/Build	Zarsky Water Chillers - Model: ACWC-300-E	The VC Package must be capable of interfacing with both the FTO PLC and treatment compound PLC. Carrier Semi-Hermetic Compressor, 460V, 3 Phase
T-101	Moisture Separator	Approximate skid dimensions to be 7' x 7'	1/4" minimum hot rolled steel	Remove 95% of all liquid droplet/30" Hg Max. Vacuum	Rated at 500 Gal. working capacity and 1000 SCFM at 22 in. Hg	tetraSOLV Filtration, 500 Gal., 316 SS, 30" Hg Vacuum. (Skid: 60"Wx60"Lx4"H)	See Table 4-12 - Major Equipment Specifications for more details. 10 microns droplet size @ 99% removal efficiency.
T-201	Moisture Separator	1'-11" Dia x 3'-6 1/4"	cross linked HDPE	60 Gal	Design/Build	Poly Processing - 60 Gal. Upright Tank	The VC Package must be capable of interfacing with both the FTO PLC and treatment compound PLC.
T-202	Cooling Water Tank, VC Package	2'-10" Dia x 7' H	cross linked HDPE	280 Gal	Design/Build	Poly Processing - 280 Gal. Upright Tank	The VC Package must be capable of interfacing with both the FTO PLC and treatment compound PLC.
T-301 & 302	Vapor-Phase Carbon Vessel	6' Dia.x 94" High/Inlet: 10"/Outlet: 10"	Double layered Epoxy Coated Carbon Steel, Vacuum Rated	4,000 lb, 3000 cfm, 15 psig, 4 in. Hg Vac.	Baker Filtrations Kleen.Air 4,000S-F	tetraSOLV Filtration VFV-5000, 5000 lbs	Operating fill: 4,000 lb virgin coconut shell carbon. See Table 4-12 - Major Equipment Specifications for more details.
T-401	Groundwater Booster Tank	5’ 4” Dia x 6’ 7” Tall	cross linked HDPE	905 Gallon	Poly Processing Company Stock Number 41100905	SAME	Vapor tight, bolted, polyethylene man way with viton gaskets with 19” opening. Sight tube/level indicator with unions and isolation valves for quick disassembly/replacement and clean-out.
T-402	Water Holding Tank	12' Dia, 8' 1" High	cross linked HDPE	4,900 Gallon	Poly Processing Company Stock Number 11004900.	SAME	Vapor tight, bolted, polyethylene man way with viton gaskets with 19” opening. Sight tube/level indicator with unions and isolation valves for quick disassembly/replacement and clean-out.
T-403 & 404	Liquid-Phase Carbon Adsorber	5' Dia x 96" High/Inlet: 4", Outlet: 4"	Double layered Epoxy Coated Carbon Steel	3,000 lb/150 GPM/75 psig	Baker Filtration Kleen. Water 3000HPV	tetraSOLV Filtration, HPAF-3000, 3000 lbs	Operating fill: 3,000 lb virgin coconut shell carbon. See Table 4-12 - Major Equipment Specifications for more details.
T-601	Air Receiver Tank	240 Gallon 30" Diameter	Painted Carbon Steel	240 Gallon	Not Specified	Manchester Tank - Vertical Air Receiver, 240 Gal	Maximum working pressure: 200 psi @ 400°F. Include a pressure gauge, pressure relief valve, automatic drain, manual drain, and galvanized steel plumbing.
T-602	Air Receiver Tank Condenstate Drum	2" Inlet/outlets	Epoxy Coated Steel	55-Gallon Drum/200 pound capacity	Not Specified	SKOLNIK - 55 Gal. TH Drum, 2 Hoops	Not Specified

TABLE 3.1 - PEMACO MAJOR EQUIPMENT LIST

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Design Specified Manufacturer Catalog	"As-Built" Specified Manufacturer Catalog	Other Specifications
T-701	Holding Tank Carbon Vessel (vent)	23" Dia x 2'-10" H	Internal: Polyamide Epoxy Resin/External: Urethane Enamel	55 Gal	Design/Build	tetraSOLV - VFD-55	55-Gallon carbon drum filled with virgin coconut shell carbon.
T-901	Caustic Soda Tank	8' Dia x 6'-10" High	Crosslinked Polyethylene Double-wall	1,500 Gal	Poly Processing Company SAFE-TANK® Stock Number 42001550	SAME	See Table 4-12 - Major Equipment Specifications for more details.
TI-101 to 108, TI-201 to 207	Temperature Indicator	TYP	Stainless Steel	30-240°F	Not Specified	Taylor Bitherm Dial Thermometer BB3102E083	3" Dial Bimetal Stem Thermometer, 30 to 240°F, 316 SS, Back or Bottom NPT male connection with thermowell
TIT-101, 102, 201, 202, 301, 401, 402, 501	Temperature Indicating Transmitter	TYP	Stainless Steel	0-200°F	Transmitter - Omega # PRTXD-200F-4-SL Thermowell - McMaster# 3957K66	Siemens SITRANS TF2 7NG3140-3BK00	Temperature Transmitter with Display and RTD sensor, straight thermowell, 1/2" NPT, 4" bore depth, 316 SS
V-101 to 108	Vapor Diaphragm Valves	6"	316 SS Trim	250 psi	Asahi Flanged Diaphragm Valves Type G	NIMCO 250 PSI Gear-Actuated Butterfly Valve, Wafer Style, Memory Stop	Wafer style, Fluoroelastomer seal, 316 SS Trim, Geometric drive, Extended neck, Molded-in seat liner, Gear operator: memory stop.
V-407	Actuated Valve	4"	PVC SCH 80	150 psig	Not Specified	OSCAF #5213-09-0400 mounted with ETI 1300 Electric Actuator	Controlled by PLC
V-452	3-Way True Union Ball Valve with Electric Actuator	3/4"	CPVC SCH80	Rated for 15 psig, 200° F	Design/Build	Spears True Union 2000 Industrial 3 Way Ball Valve with Viton seals and L port Spears Premium Electric TU Ball Valve	Controlled by PLC.
V-606	Compressed air FTO instrumentation solenoid control valve	3/4"	Brass	150 psig	Not Specified	N/A	Solenoid valve V-606 is believed to be redundant with *Anguil provided* SV-604 (shown on Anguil Dwg 12584-101 Rev. C). It was agreed on 1/8/07 between D.C and J.W. that ERM will not install. R.M. copied via email.
V-607	Compressed air supply 3-way solenoid valve	2"	Brass	150 psig	Not Specified	ASCO 1" Air and Water Solenoid Valve 8316G34	Controlled by PLC, normally closed, 150psi (AC)/125 psi (DC)
VI-101 to 111, 201, 301 to 306	Vacuum Indicator	TYP	Stainless Steel	0 to -30" Hg	Not Specified	McDaniel Controls K9S-GF (30"-0"Hg)	2-1/2" Dial Glycerin-Filled, Grade A, Back or Bottom connection, 5" Figure Interval, 0.5" Grad. Mark, 1/2" NPT male, 316 SS
VT-101, 201	Pressure Transmitter	TYP	Stainless Steel	0 to -30" Hg	McMaster# 3200K1	McMaster# 3200K1, -30"Hg-0 psi	High accuracy transducer, 1/2" male NPT, 316 SS, -40 to 212°F, < 0.25% accuracy, 10-30 VDC, 2 wire, 4-20 mA
	Vacuum Breaker (Anti-Siphon)	Inlet: 3"/Outlet: 3"	PVC or Brass	125 PSI Max	Not Specified	Plast-O-Matic Valves, Inc. VBS150VS-PV, 1.5" PVC	Installed at the highest point of the (water) treatment train as shown in Drawing M-4. Must meet ASSE Standard
	Sampling Box for LACSD	28" x 28" x 22"	Concrete	N/A	Not Specified	Pyramid Precast SB-22 Sample Box	Insalled above grade by the building contractor. Refer to LACSD std. drawing I-12 for details. Includes vent and cleanout wye.
	Condensate Sump Submittal				See Specifications	See transmittal for details	
	Process Piping Submittal				See Specifications	See transmittal for details	
	Grounding Ring				Not Specified	HWC #4/0 Bare Copper for grounding ring	
	Seismic Restraint Tech Memo				See Specifications	SHN Consulting Engineers & Geologists, Inc.	

TABLE 3.1 - PEMACO MAJOR EQUIPMENT LIST

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Design Specified Manufacturer Catalog	"As-Built" Specified Manufacturer Catalog	Other Specifications
	Light Fixture				See Specifications	See transmittal for details	
	1-Phase Main Circuit Breaker (LC-1)				See Specifications	BR3030150R	
	General Purpose Dry Type Transformer				See Specifications	T-1, 240/480V, 15 KVA, 1 Phase	
	Motor Control Center				See Specifications	Square D Model 6	
	480V Electrical Submittal				See Specifications	See transmittal for details	
	120V Electrical Submittal				See Specifications	See transmittal for details	
	Water Ball Valves & Sample Ports	Size to match pipe	PVC		Spears True Union 2000 Industrial Ball Valve or Engineer Approved Equivalent	See transmittal for details	True union ball valve with viton liner/seals.
	Water/Vapor Butterfly Valves	Size to match pipe	Match Pipe Material		Hayward Manual Butterfly Valve Engineer Approved Equivalent	See transmittal for details	Flanged Butterfly valve with viton seats/seals
	Water/Vapor Check Valves	Size to match pipe	Match Pipe Material		Spears Industrial Ball Check Valve or Engineer Approved Equivalent	Spears True Union PVC and CPVC Ball Check Valve US Valve Flanged Check Valve	True union with viton elastomer.
	Pressure Testing Plans for Vacuum Piping						
	VE Manifold Rework	N/A	N/A	N/A	Not Specified	IPS Weld-On 810 A&B 2-Part Epoxy	1) Manifold rework solves the issue of the treatment building support column interference and VE-1 condensate sump issue. The rework creates a condensate sump in place below the manifold instead of using similar to the VE sumps outside the treatment building. 2) Epoxy used to seal the piping leading to original VE sump located outside the building and creating a new sump in place below the VE manifold.
	Condensate Sump Panel Submittal	N/A	N/A	N/A	Not Specified	See transmittal for details	
	Pressure Boost System	N/A	N/A	N/A	Not Specified	See transmittal for details	
	Flow Sensors, Switches, and Transmitters	N/A	N/A	N/A	Not Specified	See transmittal for details	

TABLE 3.5.3 – ALARM LIST TABLE

Pemaco System Controls Operation

Alarms List	Device	Set Point	System	Response
Critical Shutdown Alarms				
MCP E-stop	ZSH-103	n/a	Universal	Total System Shutdown
LRP E-stop	ZSH-101	n/a	Universal	Total System Shutdown
VC E-stop	ZSH-104	n/a	Universal	Total System Shutdown
FTO E-stop	ZSH-102	n/a	Universal	Total System Shutdown
Building E-stop	ZSH-104	n/a	Universal	Total System Shutdown
Power Failure	Universal	n/a	Universal	Total System Shutdown
Air Compressor Low Pressure Alarm	PS-601	PSI	Universal	Total System Shutdown (10 second delay)
Holding Tank (T-402) High High Level	LSHH-402	n/a	Universal	Total System Shutdown (10 second delay)
Holding Tank VFD Fault (P-402)	P-402	n/a	Universal	Total System Shutdown (1 second delay)
FTO Critical Shutdown Condition (while in FTO Mode)	FTO	n/a	Universal	Total System Shutdown
Groundwater System Shutdown Alarms				
Groundwater Booster Pump Fail	P-401	n/a	GWS Shutdown	Groundwater System Offline (1 second delay)
Holding Tank Low-Low Level	LSLL-402	n/a	GWS Shutdown	Groundwater System Offline (10 second delay)
Groundwater Booster Tank High-High Level	LSHH-401	n/a	GWS Shutdown	Groundwater System Offline (10 second delay)
Groundwater Booster Tank Low-Low Level	LSLL-401	n/a	GWS Shutdown	Groundwater System Offline (10 second delay)
Secondary Containment Sump High-High Level	LSHH-501	n/a	GWS Shutdown	Groundwater System Offline (10 second delay)
Groundwater Filters High-High Pressure (F-401/402)	PT-401	25 PSI	GWS Shutdown	Groundwater System Offline (10 second delay)
Holding Tank Filters High-High Pressure (F-403/404)	PT-403	40 PSI	GWS Shutdown	Groundwater System Offline (10 second delay)
Liquid Carbon Adsorbers High-High Pressure (T-403/404)	PT-404	35 PSI	GWS Shutdown	Groundwater System Offline (10 second delay)

Alarms List	Device	Set Point	System	Response
Groundwater System Warning Alarms				
Secondary Containment Sump Pump Failure	P-502	n/a	GWS Warning	Display Only (1 second delay)
Groundwater Filters High Pressure (F-401/402)	PT-401	20 PSI	GWS Warning	Display Only (25 second delay)
Holding Tank Filters High Pressure (F-403/404)	PT-403	35 PSI	GWS Warning	Display Only (25 second delay)
Liquid Carbon Adsorbers High Pressure (T-403/404)	PT-404	30 PSI	GWSWarning	Display Only(25 second delay)
Vapor Treatment System Shutdown Alarms				
Liquid Ring Pumps Both Fail	B101/102	n/a	VTS Shutdown	Vapor Treatment System Offline (no delay)
Moisture Separator Pump Failure	P-501	n/a	VTS Shutdown	Vapor Treatment System Offline (1 second delay)
Chiller Pump Failure	P-202	n/a	VTS Shutdown	Vapor Treatment System Offline (1 second delay)
Moisture Separator Tank High-High Level	LSHH-101	n/a	VTS Shutdown	Vapor Treatment System Offline (10 second delay)
Moisture Separator Tank Filters High-High Pressure (F-501/502)	PT-501	PSI	VTS Shutdown	Vapor Treatment System Offline (25 second delay)
Vapor Conditioning Package Outlet High-High Temperature	TIT-202	150F	VTS Shutdown	Vapor Treatment System Offline Immediate shutdown in FTO Mode
Cooling Tower Fan Failure	CT-201	n/a	VTS Shutdown	Vapor Treatment System Offline (1 second delay)
Cooling Tower Pump Failure	P-201	n/a	VTS Shutdown	Vapor Treatment System Offline (1 second delay)
Condensate Tank High-High Level	LSHH-201	n/a	VTS Shutdown	Vapor Treatment System Offline (20 second delay)
Cooling Tower Low Level Alarm	LSL-2000	n/a	VTS Shutdown	Vapor Treatment System Offline (60 second delay)
Oxidizer Exhaust High Negative Pressure	PS-101	7” w.c.	VTS Shutdown	Vapor Treatment System Offline Immediate shutdown in FTO Mode

Alarms List	Device	Set Point	System	Response
Vapor Treatment System Warning Alarms				
Liquid Ring Pump #1 Fail	B-101	n/a	VTS Warning	Display Only
Liquid Ring Pump #2 Fail	B-102	n/a	VTS Warning	Display Only
Caustic Tank Low Level	LSL-901	n/a	VTS Warning	Display Only
Moisture Separator Tank Filters High Pressure	PT-501	PSI	VTS Warning	Display Only
H-202 Exit High Temperature	TIT-202	140 F	VTS Warning	Display Only
LRP #1 Low Oil Level	B-101	n/a	VTS Warning	Display Only
LRP #1 High Oil Level	B-101	n/a	VTS Warning	Display Only
LRP #1 High Temperature	B-101	n/a	VTS Warning	Display Only
LRP #2 Low Oil Level	B-102	n/a	VTS Warning	Display Only
LRP #2 High Oil Level	B-102	n/a	VTS Warning	Display Only
LRP #2 High Temperature	B-102	n/a	VTS Warning	Display Only
Condensate Pump Fail	P-203	n/a	VTS Warning	Display Only

TABLE 7.0 - LIST OF CONSTRUCTION ACTIVITIES AFTER 30-DAY SHAKEDOWN

Item No.	Description	Details
1	Solar Panel Construction	A 20 kwh/day solar system was installed to meet USEPA sustainability goals.
2	Structural Modification to Roof for Scrubber	Performed custom sheet metal fabrication to house the scrubber loop.
3	DPE-Sumps & VE-Sumps Retrofit	1. Pressure tested existing system and repaired leaks. 2. Replaced DPE-A level gauge. 3. Retrofitted VE-3 & 4 valving to be compatible with ERH system. 4. Installed four (4) pneumatic pumps with level controls in 4 DPE-Sumps, to automate water removal.
4	Moisture Separator T-101 Replacement	The first T-101 failed because it did not meet the required 29" Hg vacuum specification. The tank replacement was performed by ERM under warranty. The second tank T-101 had to be reinforced by a steel "belt" around the tank after showing signs of structural stress.
5	Earthwork	1. Spread gravel outside the Treatment Compound to create a maintenance freecompound yard. 2. Installed a vault for the water meter to protect from the Treatment Compound traffic. 3. Repaired PD-4 well vault to eliminate irrigation water infiltration.
6	Dekker Pump Oil Blow by Remedy	1. Installed six (6) additional scavenge lines to capture excess oil. 2. Replaced leaking Dekker filter. 3. Installed additional Solberg demisting inserts in the oil filters F-103 and 104. 4. Added vacuum gauges (0-30" w.c.) to Solberg F-103 and F-104 to more accurately gauge headloss.
7	Potable Water Pressure Boost System for FTO	Installed a water pressure boost system to maintain the water supply pressure per FTO operation requirements.
8	FTO Evaluation - Flow Meter, Fuel Sensitivity	Added manual magnehelic gauge. Inspected and optimized the gas control valve settings, burner temperature, checked influent vapor pressure alarms.
9	FTO-VCP Interface	TN&A installed the following items to allow the FTO to operate in tandem with the vapor conditioning package: 1. PS-101 pressure switch. 2. Barometric damper 3. Differential pressure gauge. 4. Moisture drain valve for VE-201. 5. PLC interlocks and reprogramming.
10	FTO Valve Switch FCV-400 and XV-401	Retrofitted location of valve to match Anguil construction drawings.
11	FTO Bellows Insulation Remedy	Adjusted quench chamber spray nozzles and replaced the broken quench chamber insulation inside the FTO bellows.
12	Raise T-402 LSHH Elevation	Increased virtual tank capacity, provided additional buffer against HH alarms in T-402.
13	7 QED Pumps Removal/Repaired	Sediment build up in downhole pumps caused pump shut down. Seven pumps were pulled, valves replaced, and the pumps were reinstalled several feet higher in the wells.
14	Electrical Related Retrofit and Repair	The following items were installed or retrofitted: 1. Two (2) underground junction boxes, conduit and wire for (2) telephone circuits and control wiring between the Main Control Panel (MCP) and the ERH area. 2. One hand-off-auto switch at sump pump (P-502). 3. Two 100 watt 90 minute battery back-up emergency light fixtures at equipment room. 4. One 90 minute battery back-up battery for (1) control room light fixture. 5. Conduit and wire from Vapor Control Panel (VCP) to one (1) pressure switch at FTO. 6. Two (2) broken conduits at FTO were replaced with steel conduits. 7. Conduit and type J thermocouple wire from existing thermal couple at H-202 to MCP.
15	Re-route Air-line to Double Diaphragm Pumps	Required to keep DD pumps operating after GW system shuts down, such as during GW tank High-High alarm.
16	Silencers for Dilution Valves	Added silencers for the dilution valves V-112 and V-319 to reduce noise while operating.
17	Moisture Traps for Magnahelic Gauges	Installed moisture traps to prevent unintended exhaust blower (B-301) ramp up.
18	Line Reactor for Potable Boost Pump	Installed manufacturer's recommended fix to control SCE voltage spikes
19	Resistor Package for P-402	Installed manufacturer's recommended fix to control SCE voltage spikes
20	GAC Vessel T-403 and T-404 Repair	Repaired broken fittings that attached the screen/filter inside of the carbon vessels. The replacement was required because the original fittings did not meet the manufacturer's specs.
21	Anti-Siphon for PVC line linking T-401 and T-402	Installed a PVC vacuum breaker/air relief valve for PVC line linking T-401 and T-402.
22	T-401 Chlorine Injection System	Installed a chlorine injection system to control algae build up in the holding tanks and reduce the filter bag consumption.
23	Security System for ERH Area	Installed a double-beam system with interlocks and alarm for safety concerns. The system automatically shuts down the ERH system and power supply if an intrusion occurs.
24	ERH Fence Extension along the Bike Path	Installed additional fence extension along the bike path to discourage unauthorized entry to the ERH area.
25	Custom Sample Ports for Dioxin Testing	Installed two custom 8 in diameter fiberglass spools with opposing 3 in diameter flanged sample ports for dioxin sampling.
26	GAC Backwash System	Performed design of GAC backwash system to resolve numerous high level shut downs of the treatment plant caused by excessive sediment in the pumped groundwater.
27	MW Well Cap retrofit in ERH Area	Retrofitted 20 monitoring wellheads to be compatible with ERH heat and pressure generation.

Appendices (CD)

Appendix 1 As-Built Drawings As-Built
Appendix 2 Daily and Weekly QC Reports
Appendix 3 Photo Logs, Volumes 1–6
Appendix 4 ERH Construction Drawings
Appendix 5 Well Tables and Drill Logs
Appendix 6 Building and Foundation Test Reports
Appendix 7 Drawings for Buildings
Appendix 8 Construction Delay Reference
Appendix 9 Scopes of Work for Solar Panels and Rod Iron Fence